WHAT IS CLAIMED IS:

1. A spin-valve thin-film magnetic element comprising:

a substrate, a laminate formed on the substrate, biasing layers, and conductive layers;

the laminate comprising a free magnetic layer, a first nonmagnetic conductive layer, a first pinned magnetic layer and a first antiferromagnetic layer deposited on the upper surface, away from the substrate, of the free magnetic layer; a second nonmagnetic conductive layer, a second pinned magnetic layer and a second antiferromagnetic layer deposited on the lower surface, near the substrate, of the free magnetic layer;

the biasing layers orienting the magnetization vector of the free magnetic layer in a direction perpendicular to the magnetization vector of the pinned magnetic layers; the conductive layers supplying a sensing current to the free magnetic layer;

wherein the first antiferromagnetic layer adjoining the first pinned magnetic layer fixes the magnetization vector of the first pinned magnetic layer in one direction;

the second antiferromagnetic layer adjoining the second pinned magnetic layer fixes the magnetization vector of the second pinned magnetic layer in a direction antiparallel to the magnetization vector of the first pinned magnetic layer;

and

the first and second antiferromagnetic layers comprise an alloy comprising Mn and at least one element selected from the group consisting of Pt, Pd, Ir, Rh, Ru, Os, Au, Ag, Cr, Ni, Ne, Ar, Xe and Kr.

2. A spin-valve thin-film magnetic element according to claim 1, wherein the free magnetic layer comprises a nonmagnetic interlayer, and a first free magnetic layer and a second free magnetic layer formed on the upper and lower surfaces, respectively, of the nonmagnetic interlayer, and the first free magnetic layer and the second free magnetic layer are antiferromagnetically coupled with each other so that the magnetization vectors of the first free magnetic layer and the second free magnetic layer are antiparallel to each other.

3. A spin-valve thin-film magnetic element according to claim 1, wherein the first antiferromagnetic layer comprises an alloy represented by the formula:

X_mMn_{100-m}

wherein X is at least one metal selected from the group consisting of Pt, Pd, Ir, Rh, Ru and Os, and m is in a range of 52 atomic percent to 60 atomic percent.

4. A spin-valve thin-film magnetic element according to claim 1, wherein the second antiferromagnetic layer comprises an alloy represented by the formula:

X_mMn_{100-m}

wherein X is at least one metal selected from the group consisting of Pt, Pd, Ir, Rh, Ru and Os, and m is in a range of 48 atomic percent to 58 atomic percent.

5. A spin-valve thin-film magnetic element according to claim 1, wherein the first antiferromagnetic layer comprises an alloy represented by the formula:

$Pt_qMn_{100-q-n}Z_n$

wherein Z is at least one element selected from the group consisting of Au, Ag, Cr, Ni, Ne, Ar, Xe and Kr, and q and n satisfy the relationships (52 atomic percent) $\leq$ (q + n) $\leq$ (60 atomic percent) and (0.2 atomic percent) $\leq$ n $\leq$ (10 atomic percent).

6. A spin-valve thin-film magnetic element according to claim 1, wherein the second antiferromagnetic layer comprises an alloy represented by the formula:

$Pt_qMn_{100-q-n}Z_n$

wherein Z is at least one element selected from the group consisting of Au, Ag, Cr, Ni, Ne, Ar, Xe and Kr, and q and n satisfy the relationships (48 atomic percent) $\leq$ (q + n) $\leq$

(58 atomic percent) and (0.2 atomic percent) ≤ n ≤ (10 atomic percent).

7. A spin-valve thin-film magnetic element according to claim 1, wherein the first antiferromagnetic layer comprises an alloy represented by the formula:

$Pt_qMn_{100-q-j}L_j$

wherein L is at least one element selected from the group consisting of Pd, Ir, Rh, Ru and Os, and q and j satisfy the relationships (52 atomic percent) ≤ (q + j) ≤ (60 atomic percent) and (0.2 atomic percent) ≤ j ≤ (40 atomic percent).

8. A spin-valve thin-film magnetic element according to claim 1, wherein the second antiferromagnetic layer comprises an alloy represented by the formula:

$Pt_qMn_{100-q-j}L_j$

wherein L is at least one element selected from the group consisting of Pd, Ir, Rh, Ru and Os, and q and j satisfy the relationships (48 atomic percent) ≤ (q + j) ≤ (58 atomic percent) and (0.2 atomic percent) ≤ j ≤ (40 atomic percent).

9. A method for making a spin-valve thin-film magnetic element comprising:

a laminate forming step for forming a laminate on a substrate, the laminate comprising a free magnetic layer,

two nonmagnetic conductive layers formed on two surfaces of the free magnetic layer, first and second pinned magnetic layers adjoining the two nonmagnetic conductive layers, respectively, and first and second antiferromagnetic layers adjoining the first and second pinned magnetic layers, respectively, the first and second antiferromagnetic layers comprising Mn and at least one element selected from the group consisting of Pt, Pd, Ir, Rh, Ru, Os, Au, Ag, Cr, Ni, Ne, Ar, Xe and Kr;

a first annealing step for annealing the laminate at a first annealing temperature while applying a first magnetic field to generate exchange anisotropic magnetic fields in the first and second antiferromagnetic layers so that the magnetization vectors of the first and second pinned magnetic layers are fixed in the same direction and so that the exchange anisotropic magnetic field of the second antiferromagnetic layer near the substrate is larger than the exchange anisotropic magnetic field of the first antiferromagnetic layer away from the substrate; and

a second annealing step for annealing the laminate at a second annealing temperature higher than the first annealing temperature, while applying a second magnetic field, which is antiparallel to the first magnetic field, to fix the magnetization vector of the first pinned magnetic layer in a direction which is antiparallel to the magnetization vector

of the second pinned magnetic layer.

10. A method for making a spin-valve thin-film magnetic element according to claim 9, wherein the magnitude of the second magnetic field is greater than that of the exchange anisotropic magnetic field of the first antiferromagnetic layer generated by the first annealing step and less than that of the exchange anisotropic magnetic field of the second antiferromagnetic layer generated by the first annealing step.

11. A method for making a spin-valve thin-film magnetic element according to claim 9, wherein the first annealing temperature is in a range of 220°C to 250°C.

12. A method for making a spin-valve thin-film magnetic element according to claim 9, wherein the second annealing temperature is in a range of 250°C to 270°C.